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LARGEST ROLL MAKERS IN THE WORLD
MAKERS OF THE LARGEST ROLLS

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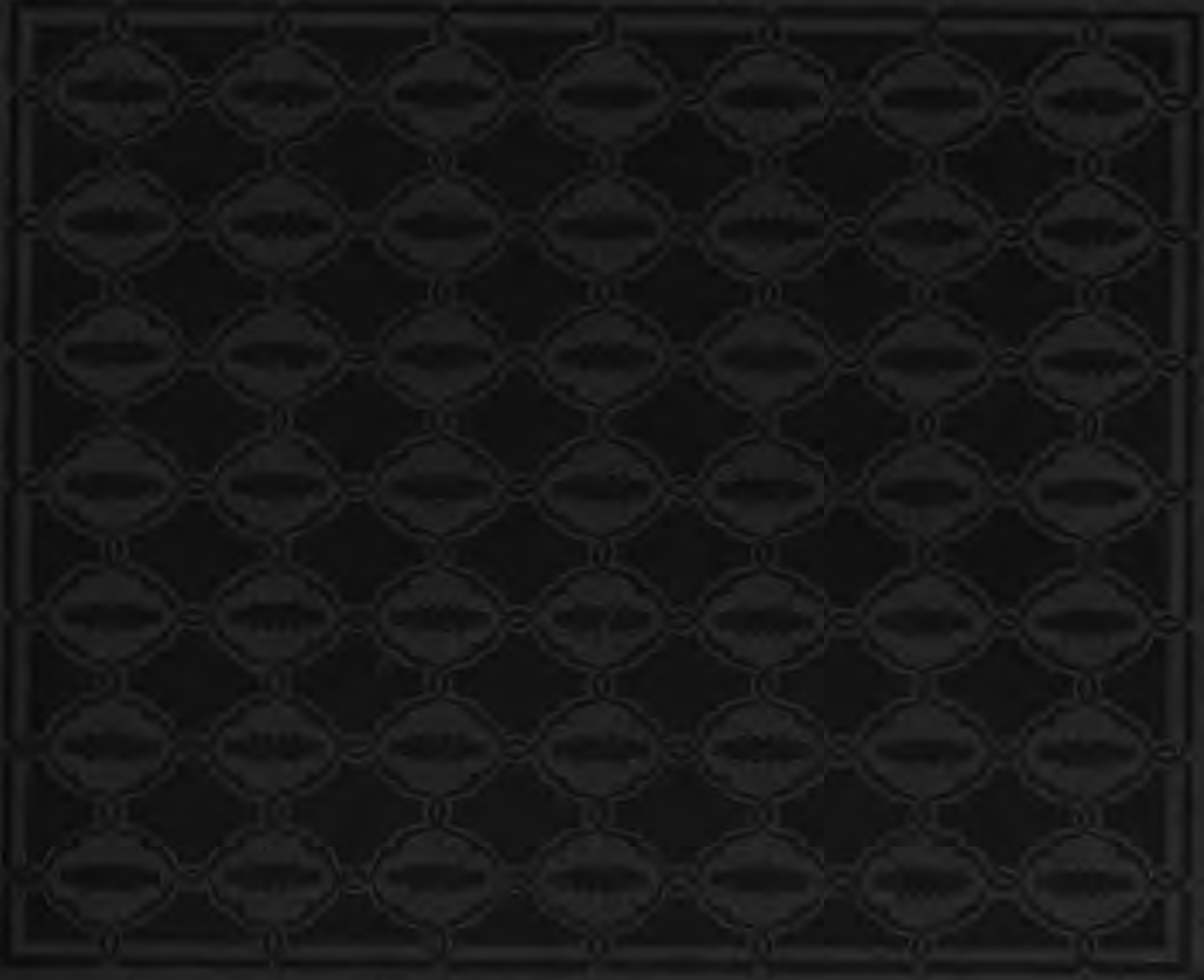

UNITED ENGINEERING & FOUNDRY COMPANY

PITTSBURG, PA., U.S.A.

ROLL DEPARTMENTS

THE LLOYD BOOTH COMPANY DEPARTMENT, OAK STREET PLANT; LINCOLN FOUNDRY COMPANY DEPARTMENT; CHILLED ROLL FOUNDRY COMPANY DEPARTMENT

MACHINERY DEPARTMENTS

THE LLOYD BOOTH COMPANY DEPARTMENT, PHELPS STREET PLANT; McGILL & COMPANY DEPARTMENT; FRANK-KNEELAND MACHINE COMPANY DEPARTMENT

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JUN 15 1908
CAMBRIDGE, MASS.

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Manager Roll Department

FRANK CORDES
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Roll Salesman

F. J. WILSON
Roll Salesman

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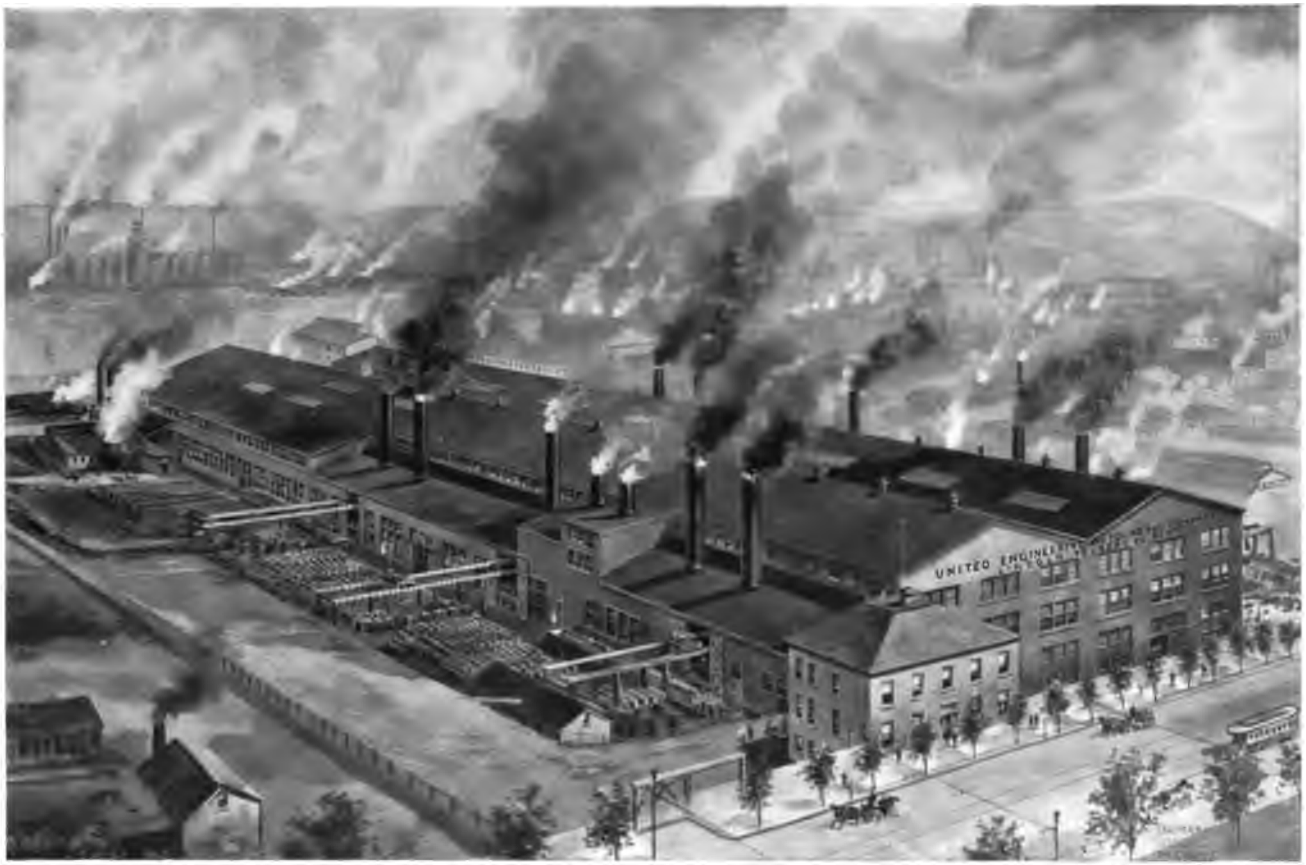

LINCOLN FOUNDRY DEPARTMENT
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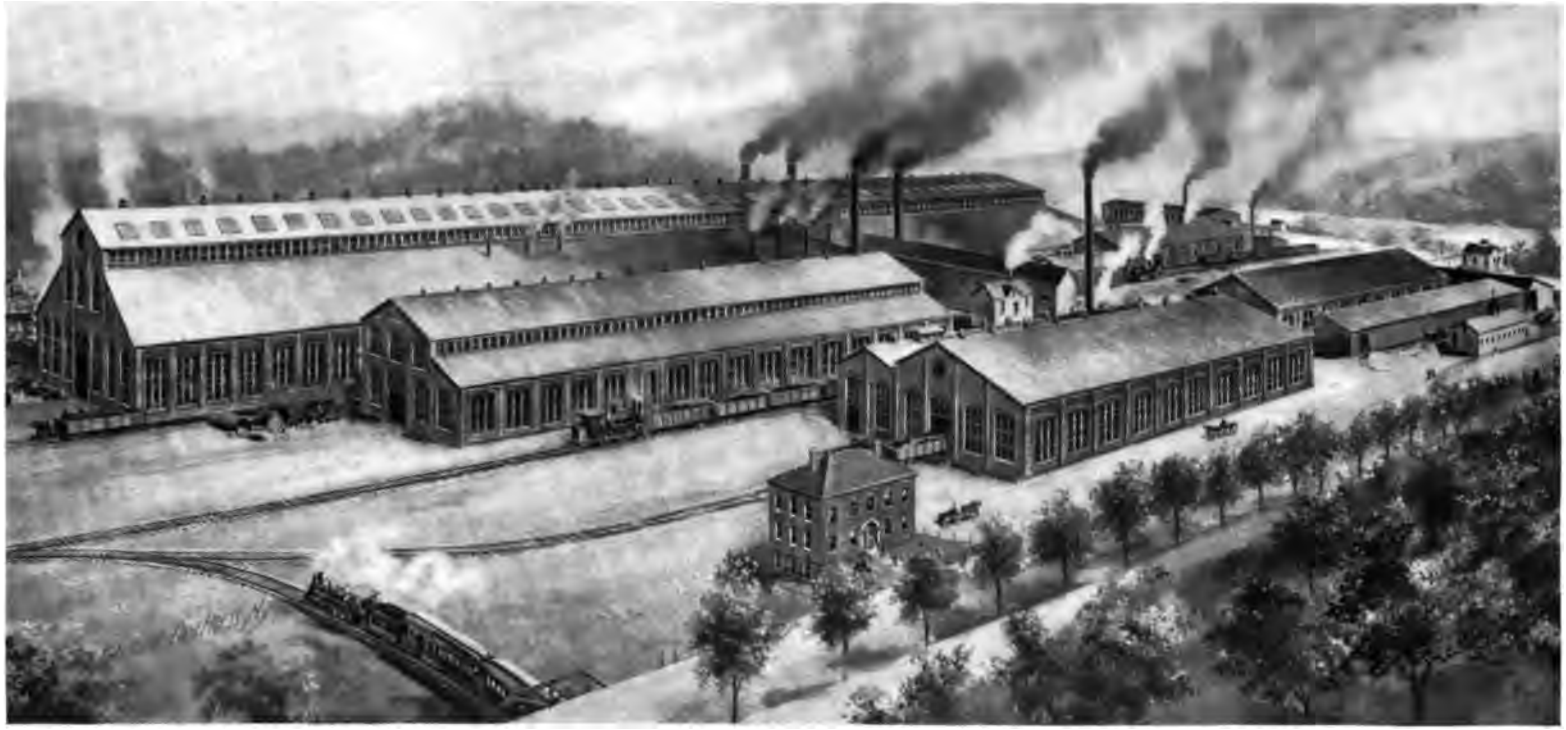
LARGEST ROLL MAKERS IN THE WORLD
MAKERS OF THE LARGEST ROLLS



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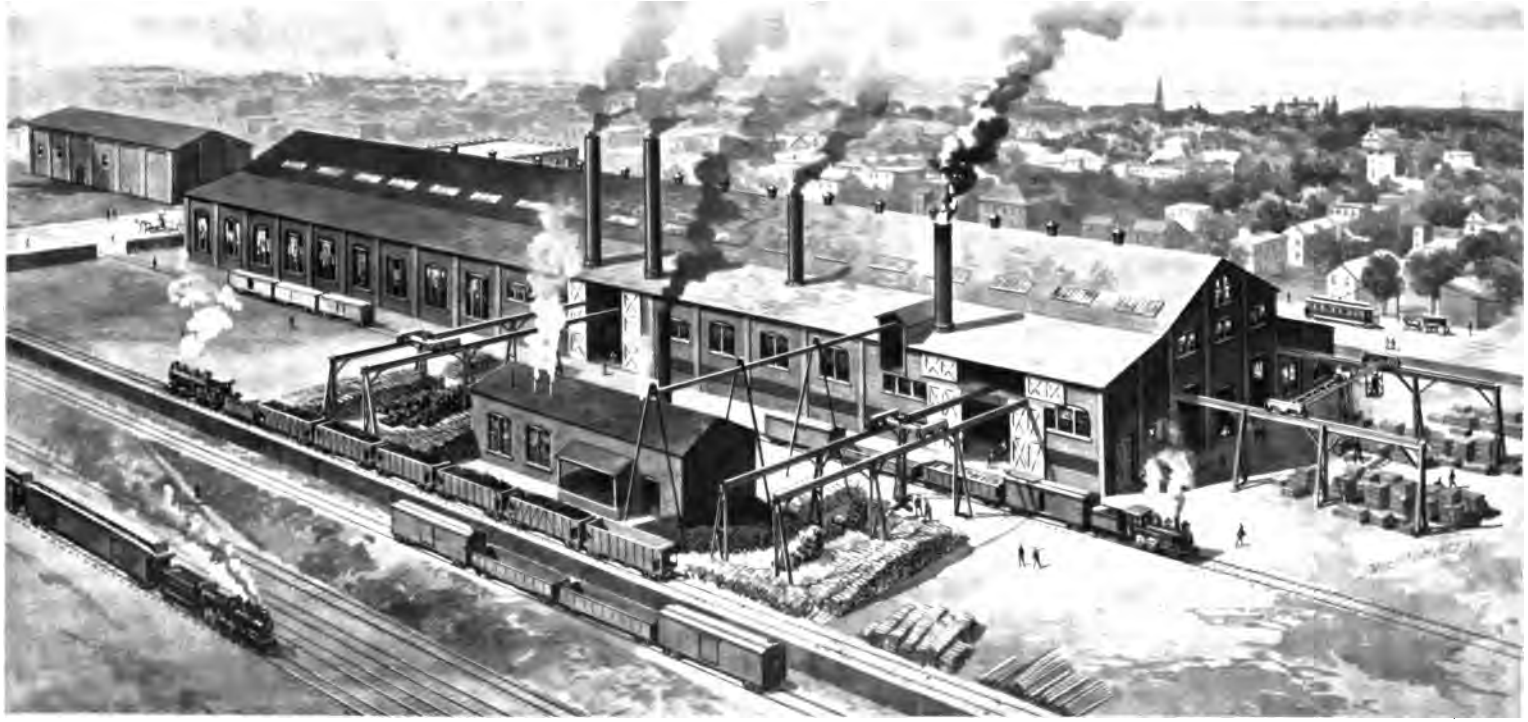

OAK STREET PLANT
LLOYD BOOTH COMPANY DEPARTMENT
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PITTSBURG, PA.

LARGEST ROLL MAKERS IN THE WORLD
MAKERS OF THE LARGEST ROLLS

MODERN progress received its greatest impetus from the time metal was first shaped between rolls, and the continued improvement of this process rendered possible and created a demand for the metal products that are today indispensable to our commercial success and general comfort. The engineer, the chemist, and the metallurgist have all contributed their knowledge, to the end that steel making has been made a science.

The evolution of the rolling mill from a pair of rolls driven by water power, rolling small blooms, to the gigantic plants of the present day, whose varied products meet all the demands of commerce, marks the grandest era of material progress the world has known.

A branch of the engineering science has been evolved whose devotees plan and devise ways and means to create and handle the enormous outputs of our modern mills, and the forming of the intricate rolled shapes required by the constructive arts is a result of their efforts.

The roll makers have also had to keep abreast of the times in furnishing rolls equal to the demands made upon them. When iron was the principal rolled product this task was comparatively easy, but since steel has almost entirely replaced iron as a mill product, and the production in the mills has increased in some instances to 3000 tons or more per day on articles such as rails, the task on the roll maker has been a severe one, with the prospect that in the near future more will be demanded.

We believe that our roll making departments have fully met the requirements of the past and will be equal to those of the future. We recognize the importance of specializing in roll making to such an extent that our roll business is entirely separated from our machinery and other business, so that rolls are handled by an organization which has made this branch of the foundry business its sole study. We make no rolls at any of our machinery plants, and no machinery at any of our roll plants.

Roll making has been a more or less unknown art to a great many of the roll users and we will attempt in the following pages to make clear the different processes necessary to the making of chill and sand rolls.

The severe uses to which rolls are subjected induce strains and stresses, to resist which the best of materials are required. The metal from which these castings are made is charcoal pig iron, the strongest and purest of

FURNACE MAKING COLD BLAST CHARCOAL IRON

This furnace has a yearly production of 1500 tons smelted iron made today. The furnaces in which this iron is made are situated adjacent to the supply of ore, limestone and fuel, and are often driven by water power. The stacks are usually of stone construction, about 30 feet in height, with the top of the furnace on a level with the stock yard. They are driven with very light blast, have from two to four tuyères, and about 150 bushels of charcoal are required to produce a ton of pig iron.

The production of cold blast iron is from six to eight tons per day, and of warm blast from fifteen to twenty-five tons per day. This iron is made in the same manner as in the early days of iron manufacture in this country and is essential to the production of a good roll, as it

SPECIMEN OF COLD BLAST CHARCOAL PIG IRON

Used in the manufacture of our chilled and sand rolls. Our forefathers used this kind of pig iron. We still use it for roll making possesses a strength and resistance to shock inherent to no other iron. We are the largest consumers of charcoal iron in the roll making business and buy those irons which experiment and investigation have proven the best for the different qualities of rolls which we manufacture.

The mixture of charcoal irons and roll scrap, of which our rolls are made, is melted in a reverberatory or air furnace. These furnaces are coal fired and of natural draft, their capacity varying from ten to twenty-five tons,—in exceptional cases larger. They can be used every day, although the furnace must be cooled over night to permit of recharging.

The furnace is so constructed that scrap can be charged in large pieces through a rear or side door according to convenience. When the scrap and metal are charged the door is closed and sealed with sand, the fires lighted, and coal fired until charge is melted.

The fire is separated from the metal by a bridge wall 18 inches in height, leaving an opening the width of the furnace and approximately 30 inches high, through which the flame sweeps with a rolling motion to the back of

AIR FURNACE

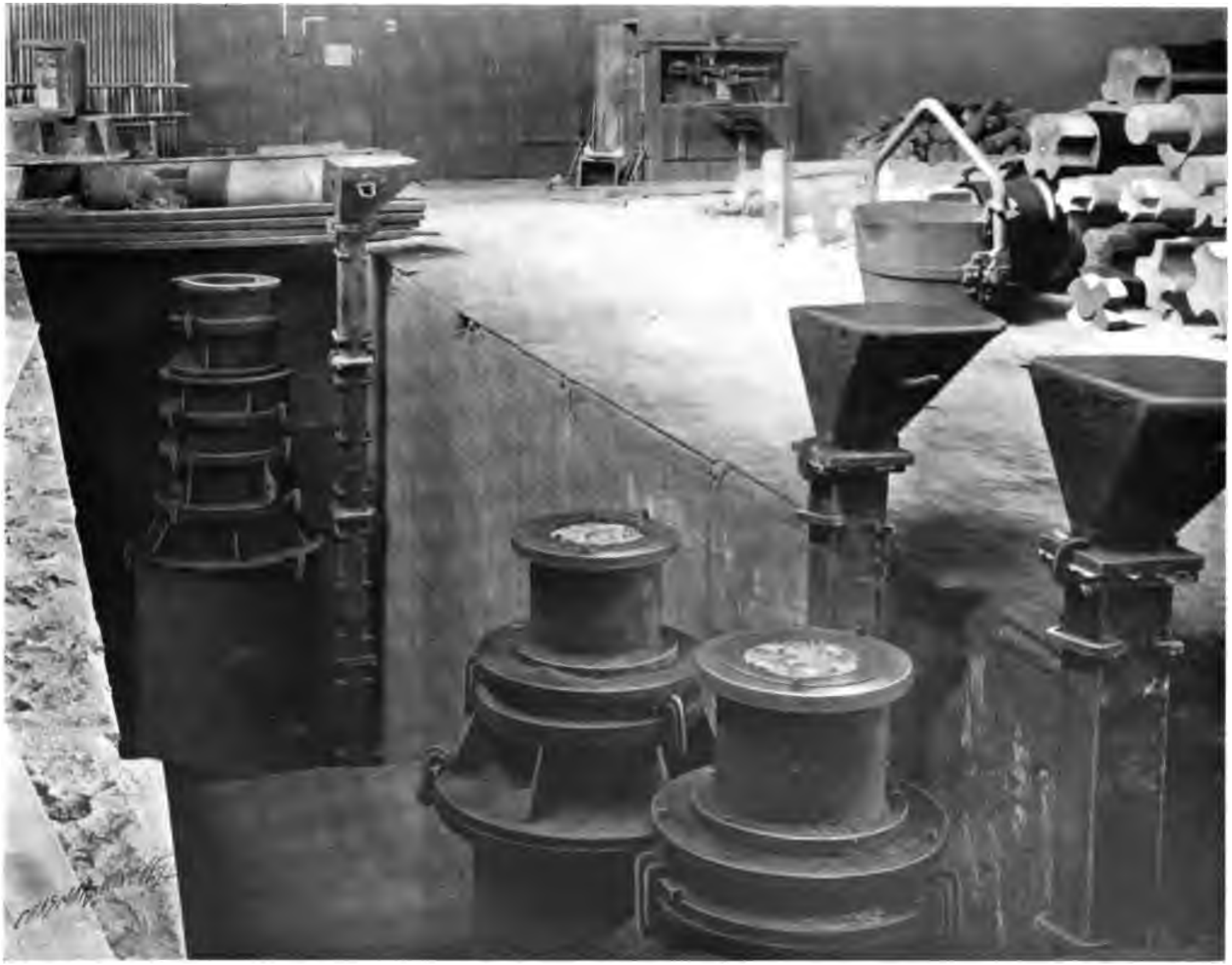
the furnace, whence it escapes through the arch at the bottom of the furnace to the stack.

This stack is 48 inches inside diameter by 60 feet high, lined throughout with fire brick, and creates the draft which causes the fuel to burn with the necessary intensity to generate a melting heat. The air passes through a bed of coal from 12 inches to 18 inches thick and the flame is almost reducing in character, the charge being suitably refined by the removal of small percentages of carbon, silicon and manganese.

TAPPING

It is this refining action of the furnace which prompts us to use the air furnace to the exclusion of other and cheaper means of melting our mixtures. The temperature of the furnace is not sufficient to melt steel and there is, therefore, absolutely no chance for the so-called burning or excessive oxidation of the metal. When the metal is melted it is protected by a silicious slag from any further furnace action.

When the iron is melted a sample is dipped from the molten bath by the

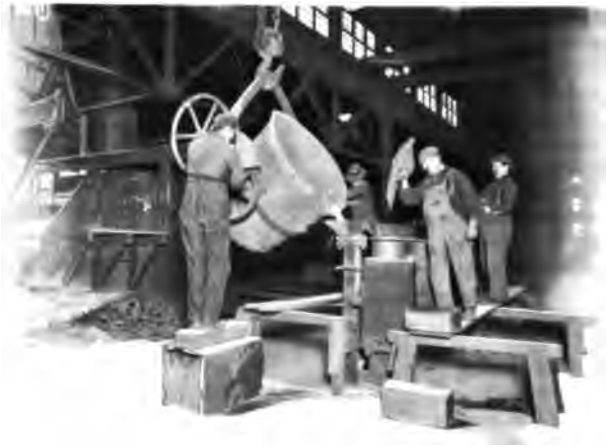


ROLL CASTING PIT

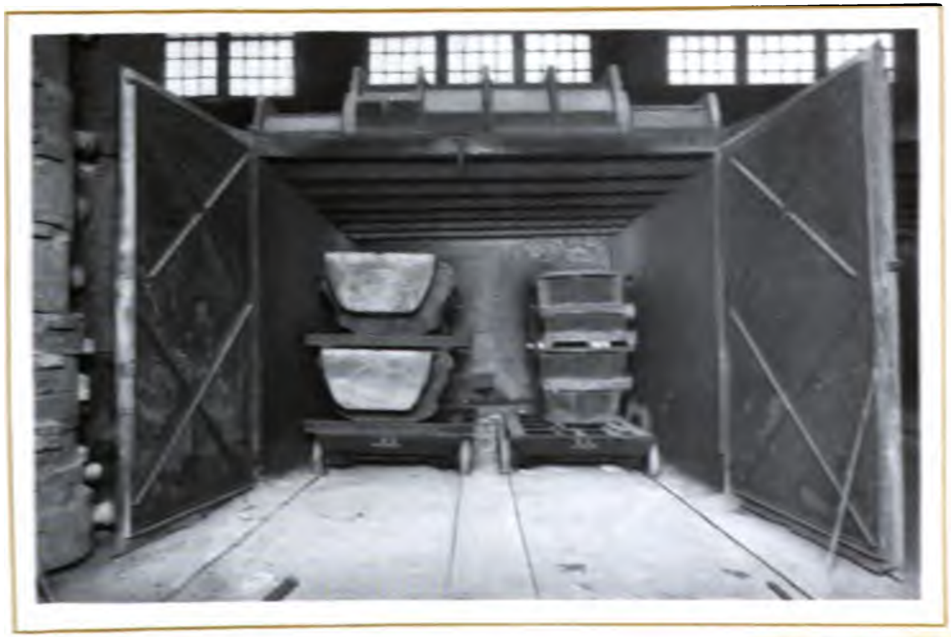
furnaceman and poured into a small mold for a test. The experience and judgment of the metallurgist in charge must govern the operation at this point in determining when the test is right for the desired kind of roll,—when the chill is of the proper depth in case a chilled roll is wanted; or of the proper hardness for a sand roll.

When the furnace is ready to pour, the tap hole, which has been sealed with a clay "bott," is opened by means of a sharp bar, and when enough iron has been run into the ladle the tap hole is closed by means of the same sort of a seal on the end of a stick, to be again opened in a similar manner until all the rolls are poured and the furnace is empty.

The metal after tapping from the air furnace into a suitable sized ladle is conveyed by an electric crane to the roll mold or flask. Our practice is to pour over the lip of the ladle for both large and small castings on account of the better control exerted over the metal. The pour is made in about forty-five seconds for an ordinary size roll and must be continuous, since an interruption, no matter how slight, will give a casting so imperfect that it cannot be used; the reason for this is that the gate or runner box which conducts



POURING



CORE OVEN

[illegible]

the metal to the rolls is cut into the mold at a tangent to promote a swirl or spin to the metal. This swirl keeps the slag or other foreign matter away from the side of the mold, and any checking of the pouring would decrease or lose the swirl, thus permitting the foreign matter to touch the side of the mold and instantly become encased in the shell of the casting, causing dirt spots and even blow holes which cannot be cut out.

METHOD OF SWEEPING ROLL MOLD

A chilled roll must be poured within a certain narrow range of temperature—if too cold it will not swirl and will be a scrap casting; if too hot it will burn into the iron mold and will be destroyed in taking from the mold.

The necks and couplings of a chilled roll, and the entire body of a sand or steel roll, are molded in sand. The sand used for cast-iron rolls is a loam sand which has been deposited in an old water course; the clay contained in it is sufficient to bond it and is refractory enough for iron castings, but will not do for steel castings as it is too fusible.

Steel castings are molded in gannister sand, to which enough fire clay has been added to effect a bond.

Sand and steel rolls are molded by sweeping the sand from a rammed flask, this sweep in outline being similar to the contour of the roll; thus each one-half flask contains one-half of the roll. The one-half flasks are then treated with plumbago dressing and dried in the core oven.

When ready for pouring the flasks are assembled and fitted together, the joints being well secured by clamps. The gating of the flasks enters on the bottom portion of the roll and is tangent to the roll body to impart the swirling motion before mentioned.

MOLD SHOWING ROLL OUTLINE AFTER SWEEPING

CHILLED ROLLS

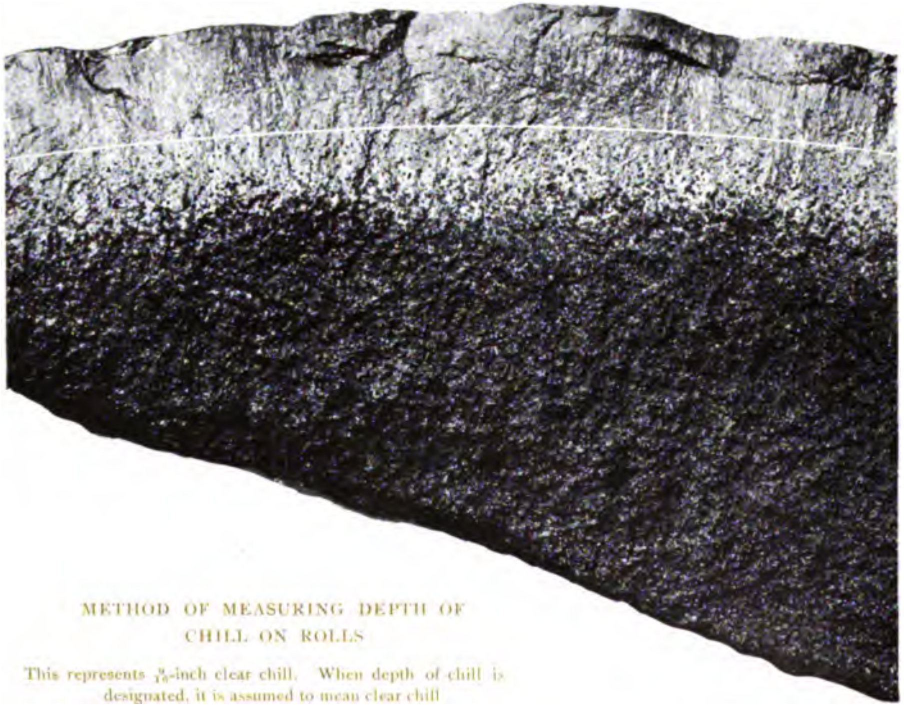
CHILLED ROLLS represent the most exacting castings with which foundries engaged in manufacturing rolling mill machinery have to contend. A chilled roll is a composite casting of which the fluid metal is chemically changed by sudden cooling so that the barrel of the roll is composed of three types of the original metal, the chilled portion, the mottled part, and the grey interior. The chilled part is hard, brittle and weak, and is white because all of the carbon of the metal is held in a combined state.

The chill is basically hard and cannot be softened by annealing without destroying the chill nor additionally hardened by tempering, but can be varied by mixture to any degree of hardness to suit different purposes; it will absorb heat and, therefore, radiate heat faster than the internal body of the roll.

The mottled portion is an admixture of chilled and grey iron and acts as the binding medium between the chilled and grey portions. This intermediary between the two extreme metals of the chilled roll absorbs heat slower than the chill but faster than the grey, is stronger

than the chilled part and is most important in acting as a bond and heat conductor between the chilled and grey portions.

The combined carbon of the mottled zone is about seventy-five per cent of the total carbon. The internal portion of the chilled roll is grey and is the strongest part of the casting.



METHOD OF MEASURING DEPTH OF CHILL ON ROLLS

This represents $\frac{9}{16}$-inch clear chill. When depth of chill is designated, it is assumed to mean clear chill

The grey iron, the carbon of which exists mostly as finely divided graphite to the extent of approximately sixty-seven per cent of the total carbon, is elastic and has a tensile strength of from 35,000 to 40,000 pounds.

The body of a chilled roll being then considered as of three layers, a white iron, a mottled iron and a grey iron intimately bonded, and taking the following table as an arbitrary analysis, this distinction is chemically conveyed in carbon only:

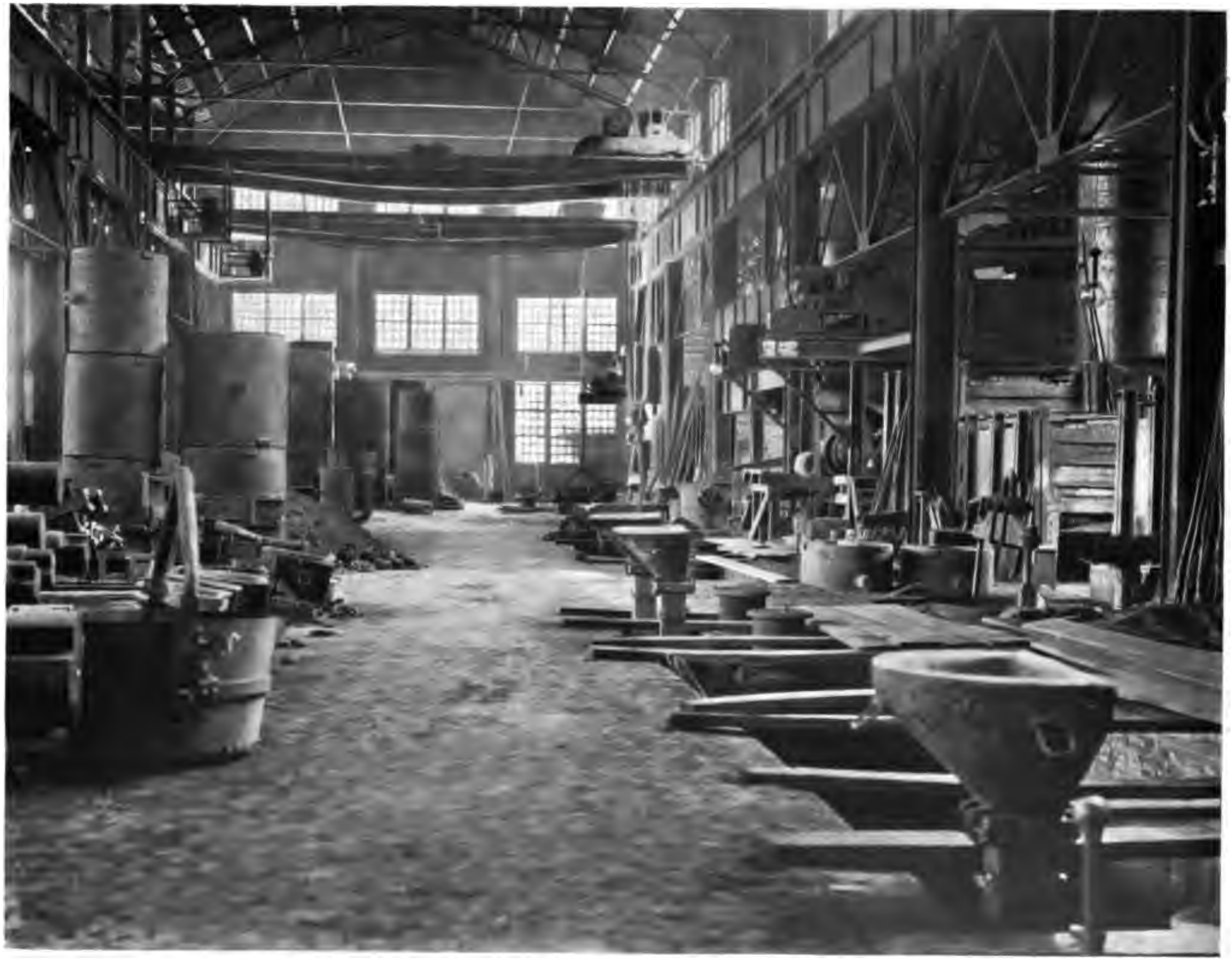
CONSTITUENT PARTS OF A CHILLED ROLL

	Total Car.	Comb. Car.	Graph. Car.	Sil.	Sul.	Phos.	Mang.
Chill	3.00	3.00	. . .	.90	.03	.200	.25
Mottled	3.00	2.25	.75	.90	.03	.200	.25
Grey	3.00	1.00	2.00	.90	.03	.200	.25

The neck and wabblers of the roll are cast in sand molds and are, therefore, grey.

The largest chilled rolls made are for rolling plates for various purposes. The chill for these rolls must be of a peculiar mild and tough nature. These qualities are required of plate mill rolls on account of the severe work to which they are subjected.

The evil of spalling is the greatest against which the plate mill operator has to contend. This trouble is mostly caused by a bearing due to center wear and other mill conditions, to fire cracks caused by stickers, or superficial heating of the roll's surface followed by a deluge of water over the overheated part, by improper water flow and many other causes incidental to mill operations. To resist the tendency to spall the chill on plate rolls of our manufacture is made different from that for any other purpose and we have built up the largest business in the country in making rolls of this type by intelligently studying the requirements of the plate mill managers. We make this class of rolls up to 42 inches diameter and will make them to any



ONE OF OUR ROLL CASTING DEPARTMENTS

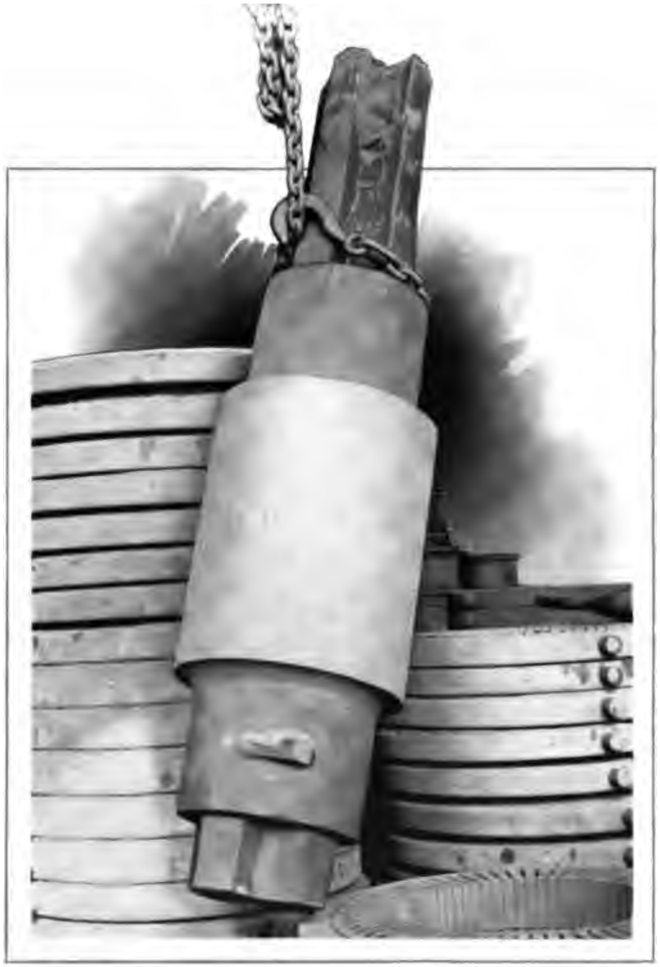
diameter the trade demands. The chills for the largest roll weigh 105,000 pounds, and 80,000 pounds of metal is required to cast this roll, and the mold from bottom plate to top of sink head is 23 feet in height.

A great percentage of large plate mill rolls is lost in casting on account of the rolls cracking, due to the fact that the mold for the body of the roll cannot be made from one continuous solid chill, but must be formed by using two or more sections, each weighing about 40,000 pounds, and the casting is very liable to crack and prove defective where these sections of mold join. The element of risk in making a casting of this size is great, involving the chance of loss both of life and property; therefore, every detail of molding, setting up, pitting and pouring the casting is in the hands of our most skillful and careful men.

We make a specialty of a specialty when we operate a plant built for making hot mill rolls exclusively and by our patented process.

In calling your attention to our C. R. F. roll made by our water chill process we introduce to you a roll "without a worthy rival" for the rolling of black plates or sheet iron. The chills are so constructed that they support, with a positive pressure, every square inch of the surface of the roll during its most critical period, *i. e.*, the instantaneous cooling from the molten to the solid state.

This action of the contracting chill performs two functions, that of giving an absolutely even chill and also of forming the chill under pressure. The resultant chill is dense and tough



C. R. F. ROLL WITH CHILLS
(Patented)

and without pin holes or surface flaws. The process enables us to use a softer and stronger iron than any other chilling device used for manufacturing rolls of this type, and this is one reason why our C. R. F. hot rolls are so superior to other rolls for rolling sheets.

Our plant for making these rolls is situated at Vandergrift, Pennsylvania, and contains four air furnaces and has a capacity for making fourteen rolls per day.

The equipment for making these castings is intricate and costly and requires the constant attention of a corps of specially trained and skilled men whose whole foundry experience centers in the making of rolls by the water chill process. These rolls, although sold at the same price as other rolls, are more costly to manufacture, but we think, and our customers know, that they are enough superior to justify us in standing the additional expense. We do not claim anything out of the ordinary for them for any other purpose than that of hot rolling, but for this process we will stake our reputation as roll makers on their being decidedly superior to any other rolls made, from the standpoint of *surface, wear and strength.*

By studying your mill conditions we will make a hot roll to meet your requirements.

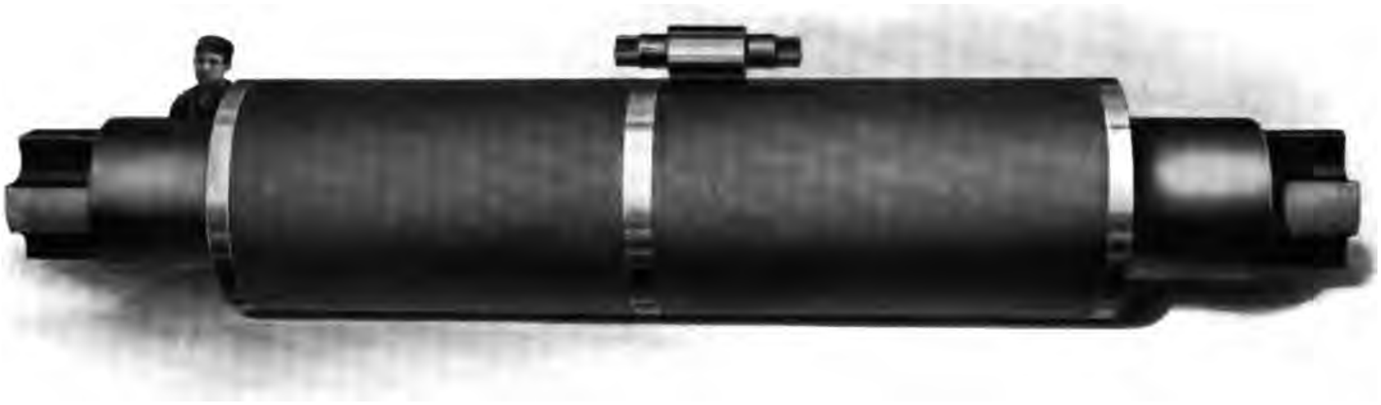
"Shape" chill rolls for rolling angles, etc., or for straightening machines are the most difficult to cast on account of the irregular contour. The collar portions of such rolls are liable to bind in the chill when casting and result in a cracked roll. For this reason and because of the many other manufacturing risks involved, the founders must charge an extra price for this class of rolls; and at that, most roll makers are not overjoyed upon receiving orders for them.

The chills for this type are very susceptible to damage by fire cracking and warping, and can only be used for each individual roll design. For this reason, the customer is charged with the chills, which he of course thereafter owns.

We will be pleased to make your requirements in this line of work.

Chill pass rolls are valuable for rolling products for the trade demanding extra fine finish. Chill end rolls for bar mills or rail mills, and chilled collar rolls for beams and channels are instances.

CHILLED ANGLE ROLL.



42 x 152 INCH AND 8 x 10-INCH CHILLED ROLLS

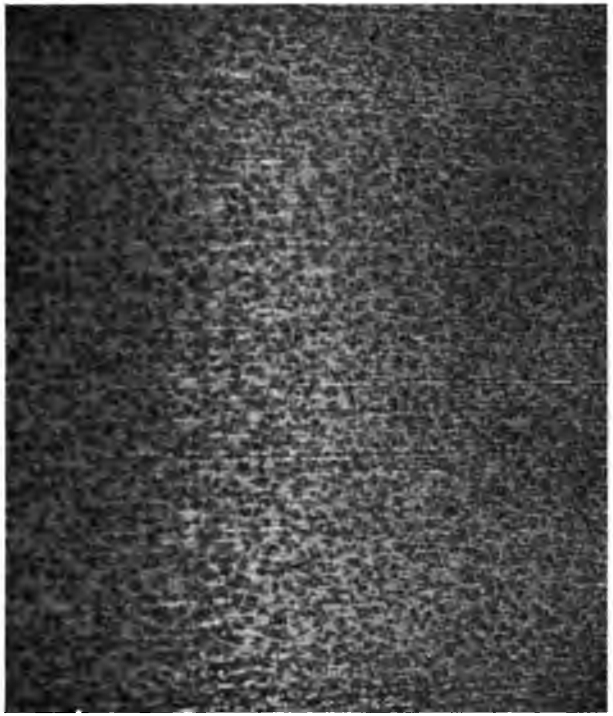
Largest roll makers in the world. Makers of the largest as well as the smallest iron, steel and chilled rolls in use for any purpose

The greater tonnage obtained by using chilled pass rolls over sand rolls is also a valuable consideration to the mill operator. The chill should be mild and tough. Some rolls are so designed that efficient chilling is impracticable; therefore, we will be glad to offer advice on this point to those who are contemplating using chill pass rolls if prints are submitted to us.

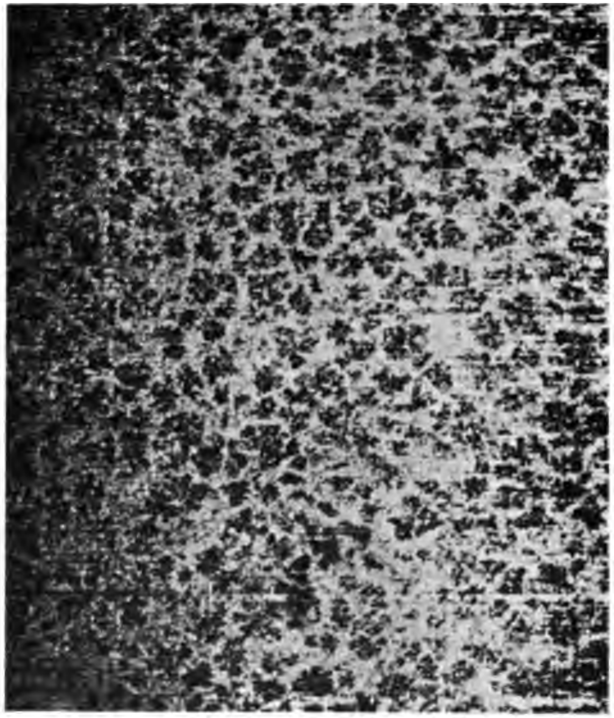
Small chilled rolls are used for a variety of widely different purposes in guide, rod, hoop and other mills and the quality of chill varies according to its intended use,—from very mild to extremely hard. We are extensively equipped to take care of this class of work and will gladly give the benefit of our extended experience to our present and prospective customers.

We would caution the users of small rolls to remember that the chilling action is intensified in its effect upon small rolls and it is, therefore, the part of wisdom to order chill as shallow as is consistent with reasonable service.

Chill is the clear white substance above *all mottles*, and in ordering, this fact should be remembered.



FULL SIZE PHOTO SHOWING ACTUAL STRUCTURE OF "LINCOLN SPECIAL" ROLLS



FULL-SIZE PHOTO SHOWING STRUCTURE OF A FIRST CLASS HARD SAND ROLL

Contrast the structure of the "Lincoln Special" roll with that of a full size photo showing structure of a better than ordinary hard sand roll. The photo illustrating full size structure of a "Lincoln Special" roll shows its homogeneity and absolute freedom from hard or soft spots, and gives an idea of the reason for its splendid wearing quality. The finishing cut after turning up a roll of this kind gives it the appearance of a chilled roll.

SAND ROLLS

A SAND ROLL is one which has been cast in a mold consisting of sand or loam and the metal is cooled slowly. The hardness of the roll depends upon the mixture used and ranges from very soft to very hard. This quality depends upon the condition of the carbon in the casting. When the graphite is in excess the casting is soft, depending upon the degree of excess graphite. When the combined carbon is in excess the roll is hard, depending upon the degree of excess combined carbon.

We are prepared to furnish sand rolls of any desired quality or of any size and for any practical purpose.

"LINCOLN SPECIAL" ROLLS

We have succeeded in perfecting a type of roll for shape work which is the most distinct step in advance ever made by a roll maker and which no shape mill can afford to ignore. The roll is one in which the graphitic carbon is very finely divided and will wear almost as well as chill, both as regards surface and reduction in diameter. The appearance of the iron of these rolls is very similar to that of malleable iron, and we have given it the name of "Lincoln Special."

Some of the records made from these rolls are phenomenal, in one instance 8800 tons of 12-inch beams being rolled from two finishing passes before requiring re-dressing. In another case 2100 tons of a shape were obtained per dressing, where previously 500 to 1000 tons were the tonnages, using good sand rolls. In many cases "Lincoln Special" has been used to decided advantage where chill rolls were impractical. It will certainly give a far greater tonnage per dressing than can be obtained from the best sand roll and with a very slight re-dressing be brought back to section.

For beams, channels and rails it is without a worthy rival. If the finishing pass on the rolls you are now using is chilled, have the leading rolls made "Lincoln Special." From this combination you will obtain greatly increased output. If the design of your finishing rolls is such that it is not practical to chill the last pass try "Lincoln Special" and you will find it very little inferior to chill.

The manufacture of this roll is by a process of which we are the discoverers and which we purpose keeping secret. It involves both metallurgical and mechanical manipulations which must be perfect to accomplish the desired result in structure, and we feel that although our competitors will endeavor to produce an imitation of this roll their chance of seriously approaching the real "Lincoln Special" quality is very remote. We highly recommend this roll and will be pleased to have our representatives call to further convince you if you are interested.

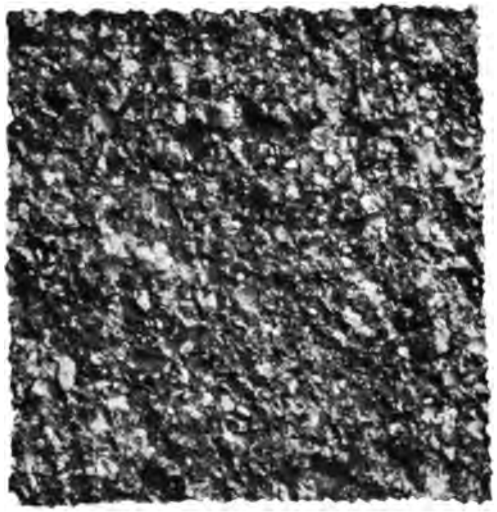
Our charge is slightly more for them than for sand rolls, but they do about twice the work.

STEEL ROLLS

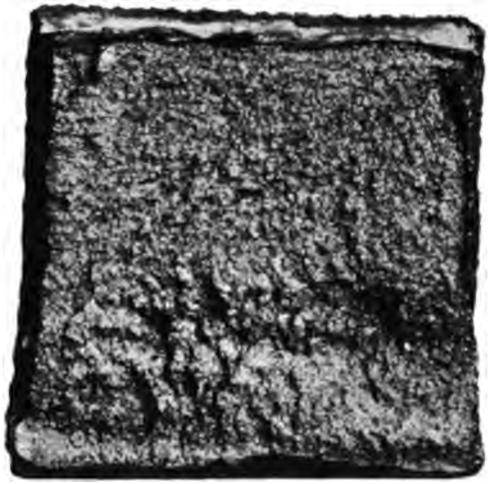
STEEL ROLLS have become invaluable to the present-day rolling mill practice for the reason that they are so much stronger than cast-iron rolls of a like diameter; and can, therefore, in certain operations, do successfully the work that would cause roll breakages or reduced outputs where sand or chilled rolls are used. For blooming mills and other mills where a large mass of metal is to be roughed down for finishing to merchant shapes, steel rolls are largely if not exclusively used and in some cases where the housings limit the size of rolls so that the cast-iron rolls are not strong enough to stand the work demanded of them, steel rolls are used for finishing shapes.

Generally speaking, the specifications for steel rolls for roughing vary from .40 carbon to .65 carbon, and for rolls for finishing from .85 to 1.25 carbon.

All of our steel rolls are made by acid steel open hearth process from the best selected stock. Each heat is carefully made up by a metallurgist who is a specialist in this line and who gives his attention also to the proper annealing of the roll when annealing is specified.



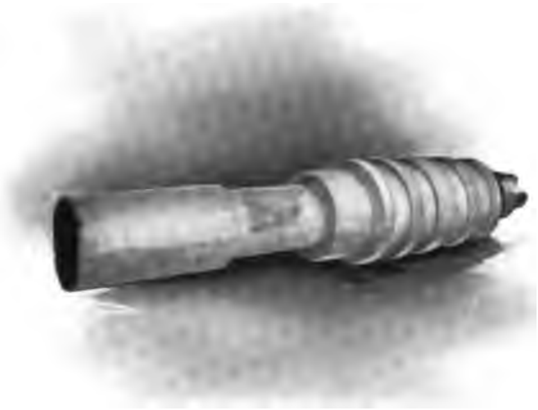
UNANNEALED STEEL SECTION



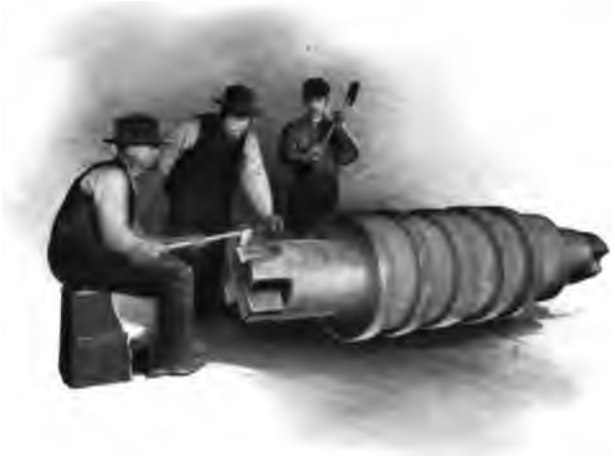
ANNEALED STEEL SECTION

A recording pyrometer is used to govern the heat control of our annealing operation. In case of flask cooling, or flask annealing, as it is sometimes called, it is our practice to leave the casting in the mold until entirely cooled. (Note cuts illustrating fracture of test bar from .40 carbon heat before and after annealing.)

In order to obtain a thoroughly sound neck and coupling, we cast the top neck plain and machine in the top wabbler. (Note cut showing cast-steel roll with head and same roll ready for shipment.)



STEEL ROLL AS CAST



STEEL ROLL READY FOR SHIPMENT

All steel rolls are cast as close to size as good practice will permit, and the same rigid inspection is made before shipment as is employed on our iron rolls.

We are prepared to furnish rolls to suit any requirements and are always glad to give customers the benefit of our advice when formulating their specifications.

Our rolls are always carefully tested and centered and wabblers proven true to barrel. Our system of inspection is such that very rarely are defective rolls shipped from any of our plants.

We try to develop in our roll shops any defects that may exist in our castings, and as a result are very successful in turning out only perfect rolls.

CHIPPING

METALLURGICAL SYSTEM

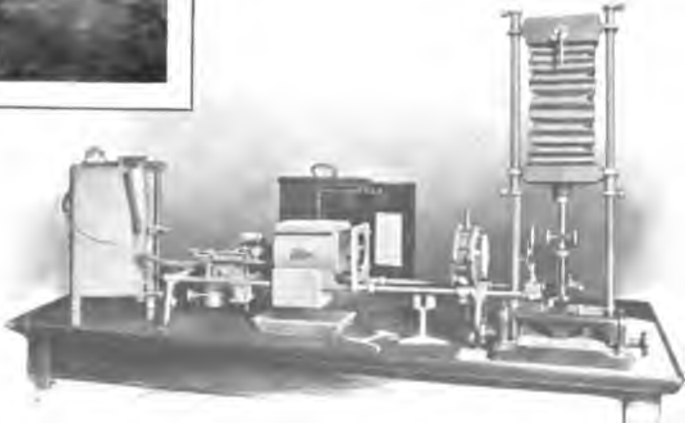
We early recognized the folly of trying to make an up-to-date product by the rule of thumb method of regulating roll mixture that was at that time universally prevalent. There being no authoritative work on the metallurgy of cast-iron we established a laboratory at our Lincoln Foundry Company Department and there pursued a painstaking investigation which in time enabled us to formulate the laws governing this hitherto unknown subject. We were, therefore, the first roll makers to classify and systematize mixtures on a chemical basis.

Our roll mixtures at each of our shops are made up to our own chemical specifications by metallurgists who have acquired their training at the laboratory at Lincoln Foundry Company Department, where all of our principal research work is done and where we are constantly experimenting to further improve the quality of our product.

Each car of charcoal pig iron and each piece of scrap is analyzed and chemically classified upon receipt at our yards so that it will be used only for making the class of rolls to which it is best suited. We practically avoid chance effects. We know the analysis of our mixtures, the strength of our metals, and the heat of our furnaces.

That our work has been appreciated by the trade is proven by the growth of our roll making plants. Lincoln Foundry Company was started with a capacity of 125 tons of rolls per month and now has a producing power of 1500 tons per month. Chilled Roll Foundry Company Department, where we make our famous water chill hot mill roll, has doubled its capacity and

INTERIOR OF LABORATORY



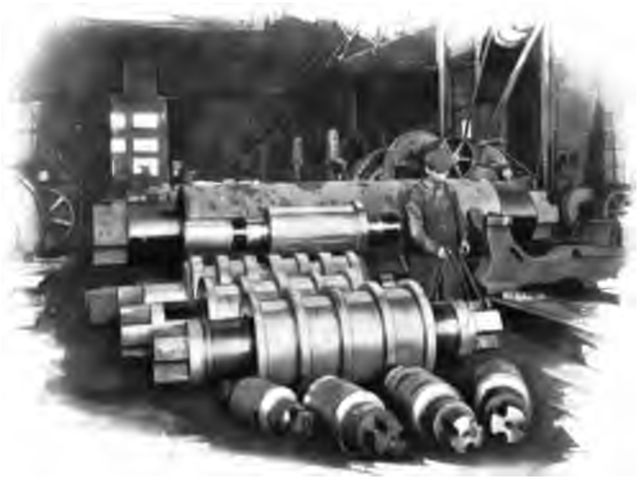
MICROSCOPIC CAMERA

LARGEST ROLL MAKERS IN THE WORLD
MAKERS OF THE LARGEST ROLLS

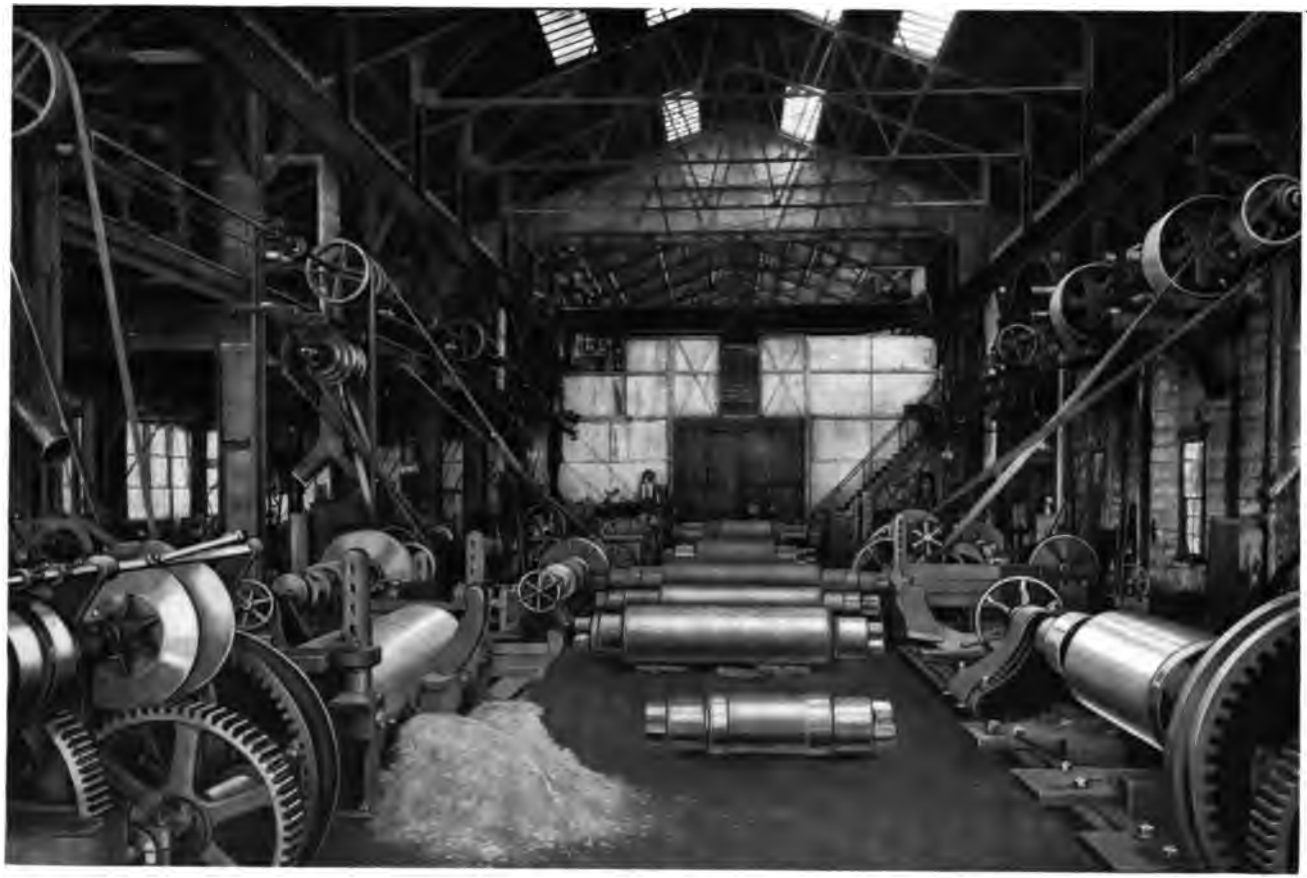
trebled its output in six years. Our business at the Lloyd Booth Company Department outgrew our capacity to such an extent that we built a new roll foundry at Youngstown, which increases our roll capacity 800 to 1000 tons per month.

We study your requirements in an intelligent manner and fill them with a product which embodies our experience with our metallurgical knowledge, and on this basis solicit your continued patronage.

In the foregoing pages, roll making has been treated from the standpoint of the metallurgist, chemist, foundryman and the operating economy of the roll user; but in addition to producing satisfactory and perfect castings, there are also the important processes of designing and turning the rolls, fitting them to produce in the mills the many and various sections required.



CALIPERING ROLLS



ROLL TURNING SHOP

LINCOLN FOUNDRY COMPANY DEPARTMENT

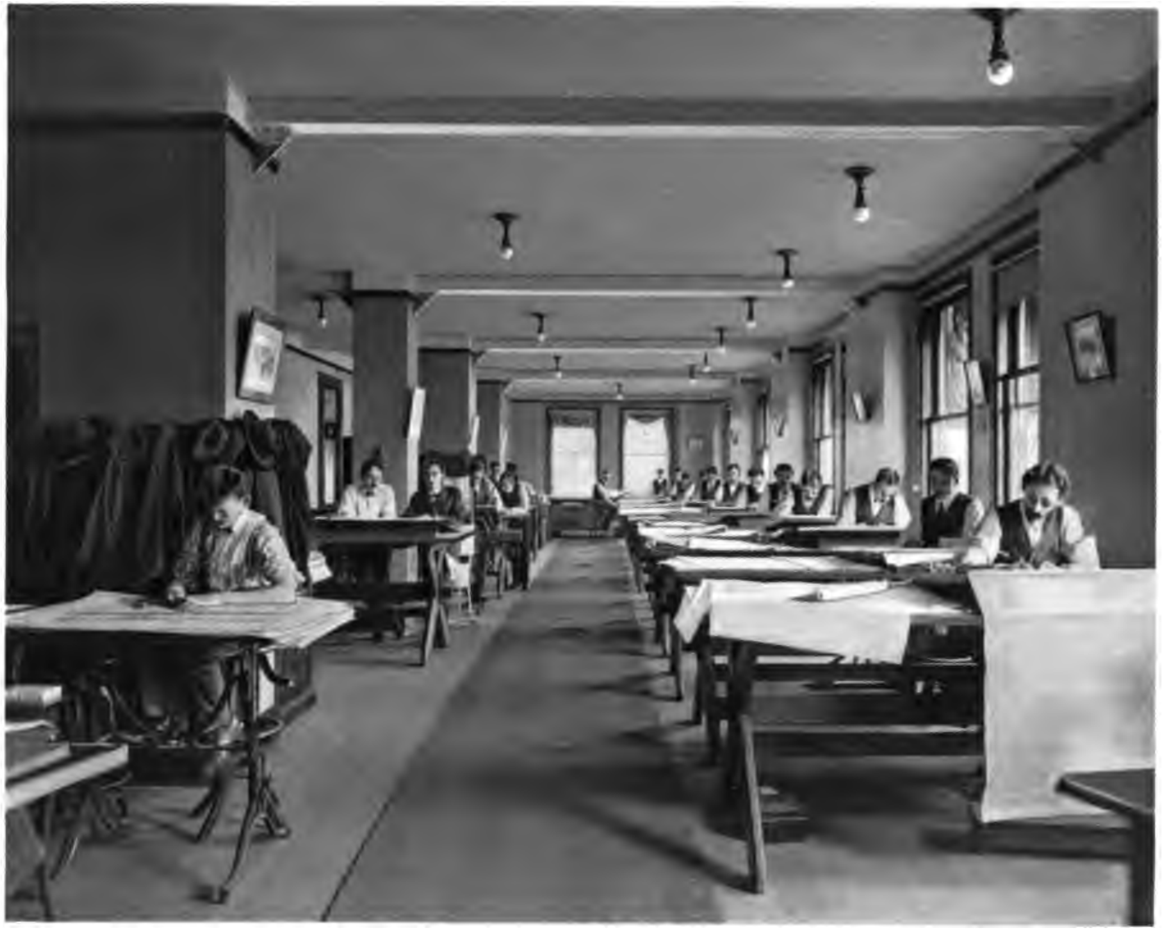
LARGEST ROLL MAKERS IN THE WORLD
MAKERS OF THE LARGEST ROLLS

ROLL TURNING

The evolution of rolled products from the simple shapes such as sheets, plates, flats, etc., to the numerous structural and other shapes of more or less intricate pattern has created a branch of engineering science classified as roll designing. The skilled roll turner is alike indispensable to the mill and the engineering foundry, and we wish to thus acknowledge their valuable service in so applying an intelligent knowledge of metal reduction that the output of the various types of mills has been vastly increased at a decreased cost and with the same mill unit. This result has been attained by the roll designer so arranging his drafts and passes that the up-to-date mill is making marketable shapes in greater tonnage and with less passes than was thought possible a few years ago.

We are thoroughly familiar with the best practice in use today for the various products, and are prepared to design and turn rolls for making special or standard shapes, and will guarantee them to produce a satisfactory section. Our foundry facilities for making chilled, sand and steel rolls, and our roll turning equipment of fifty lathes, insure prompt execution of orders.

ROLL IN ROLL LATHE



DRAFTING ROOM

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